SAN BERNARDINO MICROWAVE SOCIETY, Incorporated

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A NON-PROFIT AMATEUR TECHNICAL ORGANIZATION DEDICATED TO THE ADVANCEMENT OF COMMUNICATIONS ABOVE 1000 MC.

# W6IFE Newsletter

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At the 3 July 2003 meeting of the SBMS someone will talk about something. The SBMS meets at the American Legion Hall 1024 Main Street (south of the 91 freeway) in Corona, CA at 1900 hours local time on the first Thursday of each month. Check out the SBMS web site at http://www.ham-radio.com/sbms/.

There will be a "tune-up Party" at the park in Costa Mesa on July 26 at 10 am. Kerry, N6IZW will bring his performance measuring equipment to test rigs on the 10 and 24 GHz bands. You just get your rig ready to operate and point to the test pole. Kerry can measure your Effective Radiated Power. Then he can turn on his source and you can measure how small a signal you can hear. Kerry will also have available some performance measuring equipment for the 47 and 756 GHz bands if you let him know by the 3 July meeting or before that you will want to do that band(s).

SBMS will be having an interest table at the ARRL Southwestern Division Convention Sept 5-7, 2003 in Long Beach. Dave, WA6CGR will be one of the speakers during the convention. Dick Bremer, WB6DNX, 714-529-2800, rabremer@sbcglobal.net. Please note that ARRL did listen and put the convention on a non-contest microwave weekend. Conference registration sheet is included in this newsletter.

Last Meeting: Doug, K6JEY, Dave WA6CGR and others talked about their experiences with TWT's. Thanks to all who participated. Dick, K6HIJ talked about his trip to Moscow, Russia and meetings with hams there. SBMS and SDMG will be leading the 2005 Microwave Update per agreement with the North Texas group. The 2 GHz and up contest will be moved to July next year to allow cold country folks to better participate. 22 people present.

Scheduling:

26 July Tune up party 10 am

2-3 Aug UHF contest

7 August TBD

16-17 Aug 10 GHz and Up contest

4 Sept TBD

13-15 Sep VHF QSO Party

20-21 Sep 10 GHZ and Up contest second half

"Wants and Gots" for sale

Want HP sensor for HP431/432 meter Wayne KH6WZ 714-846-1230 KH6WZ@arrl.net.

Want WR90 flex guide 12 ft or more Pat N6RMJ 661-264-1978

Free- 6 ft rack on wheels Larry K6HLH ljohns@qnte.com 661-264-3126

Activity reported at the 5 June SBMS meeting- Chris, N9RIN finished a sequencer; Ken, K6CTW did some 1296 work; Dave, WA6CGR has a new lab space in Willington with open house on 5 July; Dick, K6HIJ built a 47 GHz waveguide tuner, had trip to Bear Lake Russia, visited with Rick, K1DS editor of Cheese Bits; Jerry, N7EME did some work on 1296 amps and is building a 1152 synthesizer; Doug, K6JEY worked on a power supply for 76 GHz rig, did some JT44 on 1296; Dennis, WA6NIA did some 2 meter EME; Jeff, KN6VR moved into new house; Wayne KH6Wzdid some DEMI transverter work; Mike, W6YLZ worked on CGR's shop, got rig mounted; Ken, WB6DTA will have new call W6DTA, has 5 w amp on 5760 MHz; Pat, N^RMJ has 1296 MHz amp working and 10 GHz rig working; Bill, WA6QYR did tower work; Mel, WA6JBD getting rigs ready for summer contests;

Above: Art Goddard, W6XD ARRL Southwestern Division Director visited the June SBMS meeting and reported news.

Hello Microwavers,

In April we reported that the replacement beacon for Santiago Peak was being tested in the San Diego Area at the ten-milliwatt level. Greg Bailey, K6QPV now reports that an amplifier has been added, raising the power to the 0.5-watt level. The beacon is again undergoing burn-in testing on a frequency of 10,368.330 MHz. The beacon's call sign is KE6JUV. Please ignore the location and grid square information given by the cw identifier. The actual location during the tests is grid DM12MQ, southeast of San Diego: 32 deg 41.802 min North, 116 deg 56.094 min South. Elevation is about 2600 Ft. This beacon should be useful to Microwavers during the June VHF/UHF Contest this weekend. 73s from Ed, W6OYJ 858-453-456

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To: The Microwave Gang 5/14/03

From: Dick, K2RIW

Re: K2RIW Discussion: Antenna Scattering Area, Part 3.

INTRODUCTION -- I have often been asked, "how big is the Scattering Area" of certain antennas. Many amateurs and engineers think the Scattering Area is usually quite small, and only of academic interest. As you are about to see, it can sometimes be VERY LARGE. I'm about to describe the biggest one

I've ever measured, and I'll discuss the internal "war" that persisted within a company (for 6 months) because of a technical difference of opinion on this subject. I believe this incident can be quite educational concerning: Scattering Area and RCS measurement, and a characteristic of human nature that can hinder a project when a strong difference of opinion occurs. But first, a few definitions are required.

RADAR CROSS SECTION (RCS) -- In the Radar world, RCS is defined by the "Projected Area" of a perfectly conducting sphere, and the signal level that such a sphere will reflect back to the Radar. For instance, a metal sphere that has a diameter of 1.128 meters has a Projected Area of one square meter -- meaning that it will project a shadow of one square meter on the ground at High Noon on a sunny day. That metal sphere could be used as a one square meter (0.0 dBsm), Standard Radar Target, for the purpose of calibrating the sensitivity of a Radar system.

RCS ASSUMPTIONS -- The first assumption is that the projected area of the sphere will cause it to intercept a predictable amount of the Radar signal -- one square meter's worth. The second assumption is that the sphere will then scatter that signal energy (equally) in all directions of free space. In reality, the sphere slightly favors the Retro-Direction, but this difference is small, and usually ignored.

RCS CALCULATION -- The hard part to understand is that many objects can have an RCS that is MUCH LARGER (in RCS square meters) than their physical area (in real square meters). This is particularly true for a Corner Reflector, or a flat metal plate at it's normal angle. For each of these the:

Maximum RCS = (4 * Pi * A^2)/(Lambda^2).

Where:

A equals the Projected Area of the plate (or Corner Reflector) at it's favored angle.

Lambda is the wavelength (in the same units).

Here is an interesting example. By using the above formula, at 1.0 GHz a one square meter of flat sheet metal has a Maximum RCS of 139.6 square meters (+21.4 dBsm). That's because the sheet of metal (at the best angle) can be very efficient at reflecting the signal back to the Radar. It would take a round metal sphere of 13.33 meters in diameter (43.7 feet), to have a Projected Area of 139.6 square meters, and to give the same echo power -- that's quite a contrast.

ANTENNA SCATTERING AREA -- During a test of the reception characteristics of almost any antenna, a portion of the energy that is presented to the antenna will not be absorbed. That portion is sometimes quantified

by the parameter called Scattering Area. For instance, if a Parabolic Dish Antenna has a surface area of 100 square feet, and if during a Far-Field boresight-angle reception test it displayed a measured Aperture Efficiency of 60% (an Effective Area of 60 square feet), then most likely that antenna has a Scattering Area slightly above 40 square feet. The extra Scattering Area is due to the fringing effect that occurs around the perimeter of the antenna, and the scattering of other structural parts. That scattered signal energy is usually scattered (to some degree) in all the three dimensional directions around the antenna (almost isotropically).

SCATTERING AREA VERSUS RCS -- A portion of the scattered energy is scattered back in the direction from where it came; this retro-directed energy would be available for reception at a Mono-Static Radar system. That portion could become the target's Mono-Static Radar Cross Section (RCS), after a conversion factor that normalized the range and the Radar's ERP. In general, the RCS energy is less than the Scattering Area energy, since it only involves the energy that is scatterer in a particular direction (back to the Radar). However, a target's RCS rating (in square meters) can be much larger than the Scattering Area (in square meters) because of the peculiar definition of RCS, and it's relationship to the projected area of a metal sphere that displays the same echo power.

THE "RCS PROJECT" PROBLEM -- About 15 years ago I worked on an Independent Research and Development (IRAD) project that had to estimate the Boresight RCS of a particular Parabolic Dish Antenna (that was unavailable to us), and the RCS had to be estimated at a frequency that was far removed (much higher) than the antenna's normal operating frequency. My colleagues and I came up with an estimated RCS number that was strongly challenged (by over 10,000:1) by the project manager. The technical difference of opinion persisted for over 6 months. This created some very frayed nerves among the affected individuals. In order to resolve the dispute, the company's Chief Scientist decided that a Proof-of-Concept measurement would have to be made on a surrogate, real operating antenna system.

THE TARGET -- The chosen surrogate target was the antenna of an FAA ASR-8 Radar System that was located at the local airport. It operated at 2.8 GHz, and we were going to make an RCS measurement at 16.25 GHz (5.8 times higher in frequency), at the frequency of a portable (Man-Pack) Radar system. The RCS measurement was going to take place from the balcony of a 10th floor hotel room that was located 5 miles away. It had a line-of-sight path to the airport radar.

PERMISSIONS & SAFETY REQUIREMENTS -- The FAA gave us permission for the test, and they had our telephone number to cancel the test if any interference appeared on their Radar screen. The company's Safety Department tested the Biohazard characteristics of the portable Radar and declared it to be safe in the manner in which we intended to use it. The hotel manager gave us permission to rent the room and run the test, particularly because it was an off season, and the top few floors of the hotel were empty.

THE CANCELED TEST -- The project manager developed a strong opposition to the test. He convinced the company vice president to order a cancellation of the Proof-of-Concept test by declaring that the measurement was a waste of company resources because there would be too little echo power to measure, and there was a chance that the portable Radar would cause an interruption of a hotel patron's heart pacer, and the company would be sued. Thus, the project manager had succeeded in getting the whole project canceled for the third time. This greatly frustrated the involved employees.

THE "K2RIW RADAR" MEASUREMENT -- Because of my faith in the project I decided to proceed on my own time. I prepared and calibrated a pair of 300 milliwatt 10.368 GHz "White Boxes" with the 29" dishes as a CW Radar. I and two fellow employees went to the hotel on a weekend with about 500 pounds of test equipment and we made the RCS measurement of the FAA Radar by using my Ham Radio license to legalize the transmission. That "flee powered CW Radar" made a measurement that demonstrated significant 10.368 GHz echo power from the FAA Radar antenna, and this result was reported to the company's Chief Scientist.

THE RESCHEDULED MEASUREMENT -- Based on the encouraging measurement with the "K2RIW CW Radar" the Chief Scientist decided to take over the management of the project, and he re-opened the project for the 4th time. We were now authorized to use one of the company's portable Radars, and a more formal Proof-of-Concept test was scheduled to take place at a US Military Base (with their permission) that had both a FAA

ASR-8 Radar and a nearby mountain about 3 miles away. By locating the portable radar at various points along the road that was on the nearby mountain, the RCS measurement of the FAA Radar could be made at various elevation angles to the FAA Radar.

THE RCS MEASUREMENT PROCEDURE -- I was using a Man Pack AN/PPS-5 portable Radar that put out 1 KW pulses at 16.25 GHz into a 42 by 14 inch Bat Wing antenna (38 dB gain). This is a battery-powered transistorized Radar with a Magnetron final transmitter that puts out 100 nanosecond pulses at a PRF of 10 kHz (an average of one watt output). I found the correct altitude along the road on the mountain (690 feet) that put me in the peak of the 2.8 GHz beam from the FAA Radar (at +2.5 degrees elevation). I found that I had to put a 20 dB pad in front of the PPS-5 Radar receiver to keep it from saturating from the 16.25 GHz echo power I was getting from the 2.8 GHz FAA Radar antenna, when it's rotating dish was aimed at me.

RADAR CALIBRATION FOR RCS MEASUREMENT -- I rechecked the RCS Measuring Calibration of the PPS-5 Radar by performing three tests: a calibrated corner reflector RCS test, a signal generator receiver response test, and a directional coupler plus Spectrum Analyzer transmitter power output test. During the RCS measurements, the strength of specific echoes were measured by using a pulsed signal generator to inject (with a calibrated directional coupler) equal-amplitude pulses (at almost the same range) into the portable Radar's receiver. The receiver responses were being observed on an oscilloscope (an A-scope display).

HOW BIG WAS IT? -- After the on-site calibration tests, I confirmed that the FAA Radar (at it's boresight angle) was generating a 16.25 GHz RCS of 57,500 square meters (+47.6 dBsm), with a pair of brief peaks (on each rotation) that were even higher. There are very few Radar discrete targets on Planet Earth that are much larger than that. That's almost the RCS you will observe from a full-sized Aircraft Carrier at a broadside angle. It would take a metal sphere 271 meters high (888 feet) to equal the same Radar echo power.

WHY THE >>BIG<< DISAGREEMENT? -- The original project manager considered himself to be a "Radar expert"; this caused him to arrive at the following three (3) conclusions. He had heard that parabolic dish antennas are capable of creating big echoes. Therefore, a few years earlier he had ordered the testing of some of the parabolic dish reflectors that were in the company's warehouse. (1) The feed horns were not present (he didn't think that mattered), and thus the measured echoes were very small. (2) He reasoned that the expanded aluminum mesh that made up the parabolic reflector of the 2.8 GHz FAA Radar antenna would allow most of the 16.25 GHz signal to pass through without substantial focusing, or reflection. (3) He further reasoned that the FAA Radar's 2.8 GHz feed horn would not respond to the 16.25 GHz signal. He was extremely wrong on all three assumptions.

WHAT HAPPENED NEXT -- The project proceeded to the next steps toward developing a product. The original project manager had earlier told many company officials that the employees on this project (particularly Dick, K2RIW) were very foolish to believe that a large echo would be realized. He lost much of his credibility after the Proof-of-Concept measurement was finally made. Soon after the measurement he resigned from the company (after 20 years of employment); many believe that the embarrassment of this incident was a contributing factor.

NEW RESPECT? -- For the next 5 years my pronouncements and estimations (concerning RF and radio matters) went unchallenged. It is nice to be respected and appreciated, and I received some company (and IEEE) awards because of the results of this and two similar projects. But, I could no longer obtain an objective opinion when I asked my fellow employees for a confirmation of my speculative ideas -- they were afraid to challenge me. They sometimes gave me credit for knowledge I did not have.

WHAT MADE THE HUGE RCS? -- When a pulse from the 16.25 GHz portable Radar arrived at the boresight angle of the antenna of the FAA Radar, the 15 foot wide dish reflector (with 100 square feet of area) experienced a nearly uniform Amplitude Distribution. Despite it's expanded aluminum surface

(with some energy feeding through the surface) and surface roughness, it focused a certain portion of that energy at the center of the antenna's 2.8 GHz feed horn. The horn was not "tuned" for that Amplitude Distribution (particularly not at 16.25 GHz) and it rejected a good portion of the focused energy. The rejected energy then

become scattered by the horn, and a good portion of that scattered energy was reflected back to the parabolic reflector. The reflector "refocused" that energy back into a beam that was directed at my portable Radar.

THE HORN CREATES MOST OF THE ECHO -- If the Radar's 2.8 GHz feed horn had not been present, then the 16.25 GHz focused energy would have simply passed through the focal point, and been dispersed into space over the very wide angles that the parabolic reflector subtends (from the viewpoint of the feed horn). You could say that the feed horn created the Scattering Area that, ultimately, resulted in the large RCS, because without it the maximum RCS would have been over 1,000 times smaller.

EVEN STRONGER RCS? -- As the FAA Radar antenna rotated, the 16.25 GHz signal that was focused by FAA Radar's parabolic reflector would sweep across the region of the 2.8 GHz feed horn. At the proper boresight angle, the focused 16.25 GHz signal would be located at the center of the 2.8 GHz feed horn, and a certain portion of that signal would proceed down the horn, and be propagated by the 2.8 GHz wave guide to the Radar's receiver (where much of it would be absorbed). However, at the two times during each rotation that the antenna was aimed slightly to the left or right of the boresight angle to the portable Radar, the 16.25 GHz signal would be focused on the outer edges of the 2.8 GHz feed horn. At these times the feed horn could accept none of the focused energy, thus it was all scattered. During these two very brief periods, the RCS was considerably greater than the recorded value (57,500 square meters). The instrumentation that I was using was not able to catch and record the value of the two peaks; it is possible that they were almost 10 dB stronger. Thus, a graph of the 16.25 GHz echo power versus antenna rotation would display a pair of "rabbit ears".

CONCLUSION -- I hope the Microwaver's find this saga to be educational, and maybe they can use the information in some of their future projects.

73 es Good UHF/SHF/EHF DX, Dick, K2RIW. Grid: FN30HT84DC27 web: http://consult-li..com /listings/Rknadle.htm .

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Above: Wayne, KH6WZ at the June SBMS meeting with his 10 GHz rig.

The San Bernardino Microwave Society is a technical amateur radio club affiliated with the ARRL having a membership of over 90 amateurs from Hawaii and Alaska to the east coast and beyond. Dues are $15 per year, which includes a badge and monthly newsletter. Your mail label indicates your call followed by when your dues are due. Dues can be sent to the treasurer as listed under the banner on the front page. If you have material you would like in the newsletter please send it to Bill WA6QYR at 247 Rebel Road Ridgecrest, CA 93555, bburns@ridgecrest.ca.us, or phone 760-375-8566. The newsletter is generated about the 15th of the month and put into the mail at least the week prior to the meeting. This is your newsletter. SBMS Newsletter material can be copied as long as SBMS is identified as source.

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